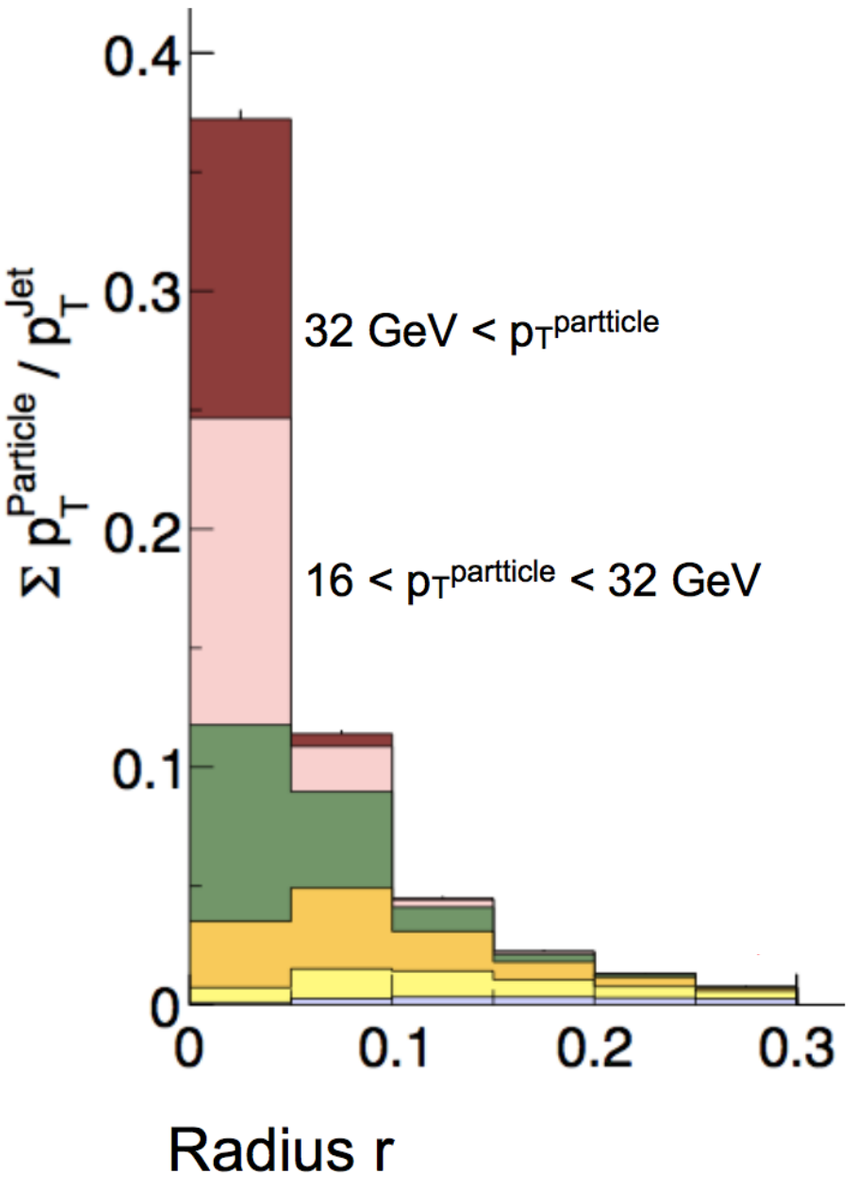

Jet structure topical group meeting

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29 April 2016
sPHENIX Jet Structure Meeting

Last time

- First meeting on 15 April 2016: https://indico.bnl.gov/conferenceDisplay.py?confId=2009
  - ➡ discussed organization and physics scope of the group
  - ➡ discussed general strategy for addressing Berndt's charge
- Given short timescale, we were advised in sPHENIX General Meeting to identify a small, specific set of studies & plots sooner rather than later
  - ➡ in this meeting, we will attempt to do just that
  - ➡ specifics of "de-scoped" detector configurations are now being discussed within Collaboration

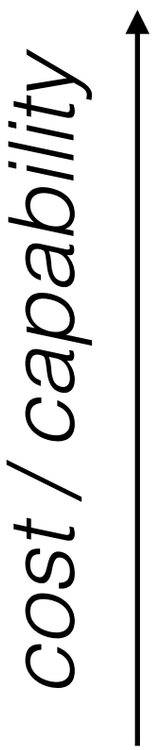
Timeline (as previously envisioned…)

	Su	M	Tu	W	Th	F	Sa
April	24	25	26	27	28	**29**	**30**
May	**1**	2	3	4	5	**6**	7
	8	9	10	11	12	**13**	14
	15	16	17	**18**	**19**	**20**	21
	22	**23**	**24**	**25**	**26**	**27**	**28**
	29	30	**31**				

- Only *four* weeks and change until 31 May deadline
- Possible **Jet Structure meeting** dates
- Strawman date for **defined geometries + MC generation**
- Proposed plots shown at **sPHENIX Collaboration Meeting**
- **Finalize and document** results (led by SP)
- Deadline for **Berndt's charge**

Detector configurations

- Still waiting for specific direction from Spokespersons + Project Management + Executive Committee
- However, we may be asked to evaluate the following:



  - ➡ a configuration which can “do all the physics” (cost irrelevant)
  - ➡ the “baseline” configuration described in C&S review in the Fall ($82m)
  - ➡ 2-3 configurations with $75m price tag
- As an exercise, consider Jamie’s strawman descoping options at EC meeting & discuss implications for our group

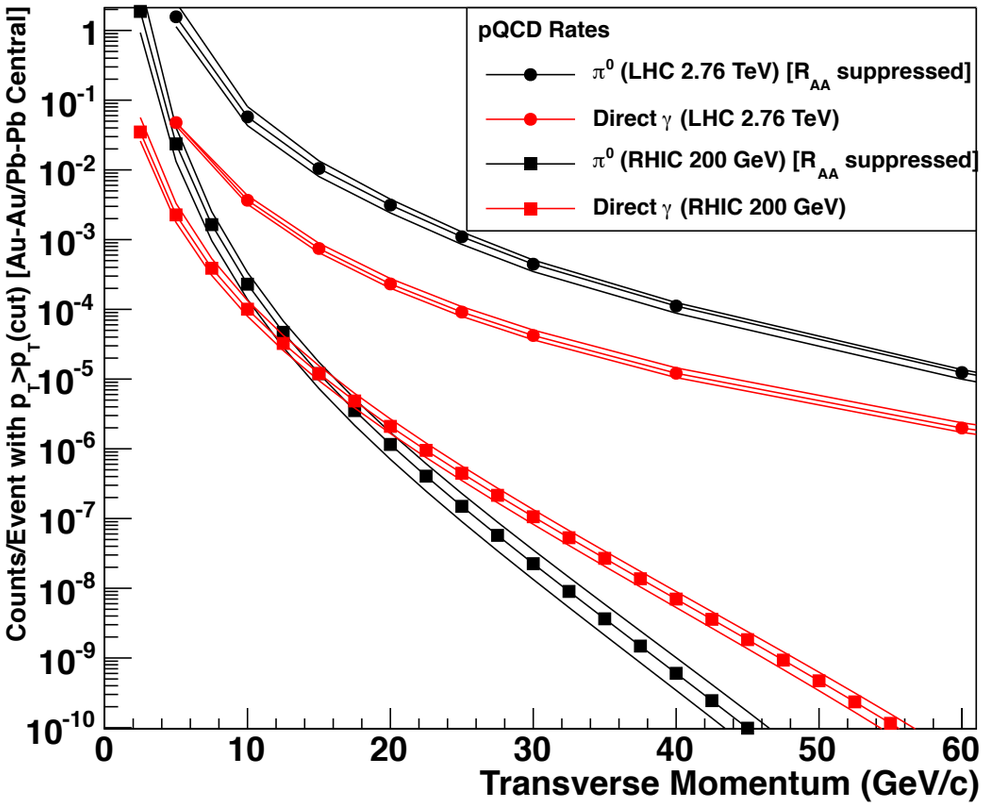
Nagle consideration A

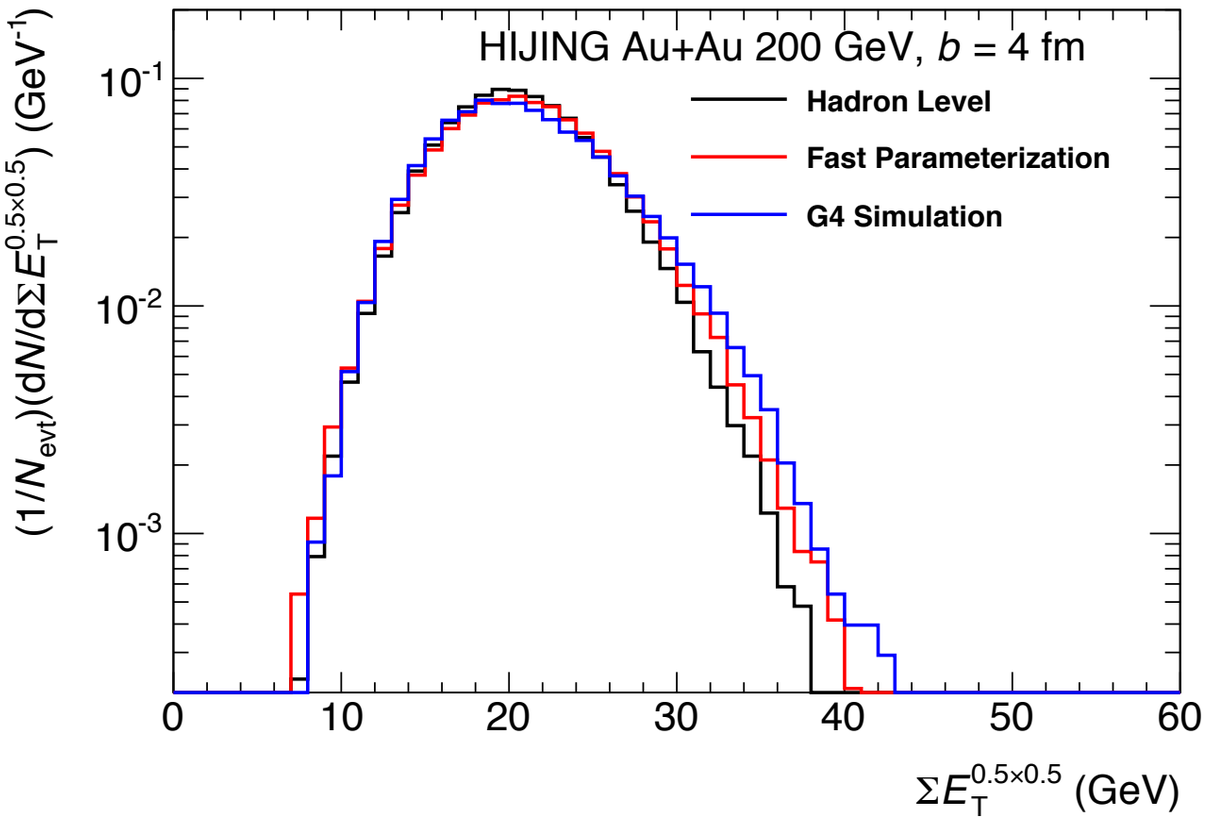
One Option – can we build all the EMCal towers, and gang the readout 2x2 → saves $3M

Minimal impact on jet and direct photon physics (direct photons > 15 GeV where they dominate is already beyond 2γ separation anyway).

- EMCal segmentation would still be smaller than HCal even with 2x2 ganging
  - ➡ minimal impact on jet performance
  - ➡ minimal, if any, impact on track → cluster matching?
- Impact on photon issues also probably minimal (see next slide)
- <u>Likely no impact for Jet Structure group</u>

Photon performance?





- Two major issues for photon ID with p_T > 20 GeV in Au+Au:

1. Separation of one-photon clusters from merged $\pi^0 \rightarrow 2\gamma$ decays
   - infeasible at given EMCal segmentation & photon p_T range
   - left plot: γ/π^0 ratio > 1 and rising in this regime anyway
2. Isolation of photon atop fluctuating UE background
   - MIE studies demonstrated that UE driven by fluctuations at truth-level, not by calorimeter response *per se*

Nagle consideration B

One Option – can we build only half the EmCal Towers
→ Saves $2.1M (towers) + $2M (electronics) = $4.1M

Could cover |eta| < 0.5 and plan to build out as much as possible later.

- Direct photon physics acceptance down by factor of 2.
- Upsilon physics down by a factor of ~4 (easy to check w/o GEANT).
- What is jet resolution in region with only HCal (easy to check with GEANT) – boundary region is not great, but probably correctable.

- Jet energy measurement affected across the boundary

  ➡ performance particularly η dependent

- Statistical projections for photon measurements decreased

Nagle consideration C

One Option – split the outer HCal into two longitudinal segments and only build the inner one (i.e. reduce the total calorimeter number of interaction lengths). → saves (?) - $2-3M depending on split

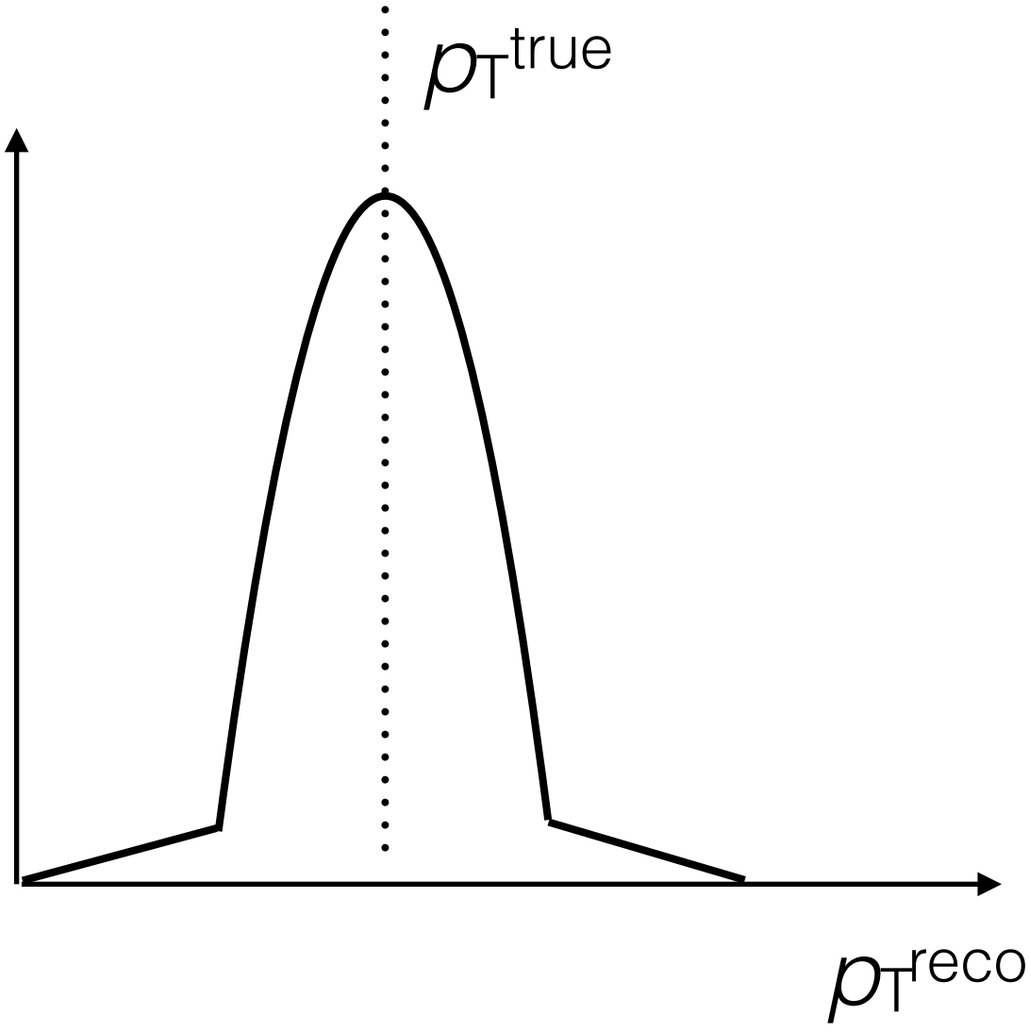
* Note that one actually only needs a fraction of the HCal outer steel to return the flux. Note later it doubles the outer HCal electronics

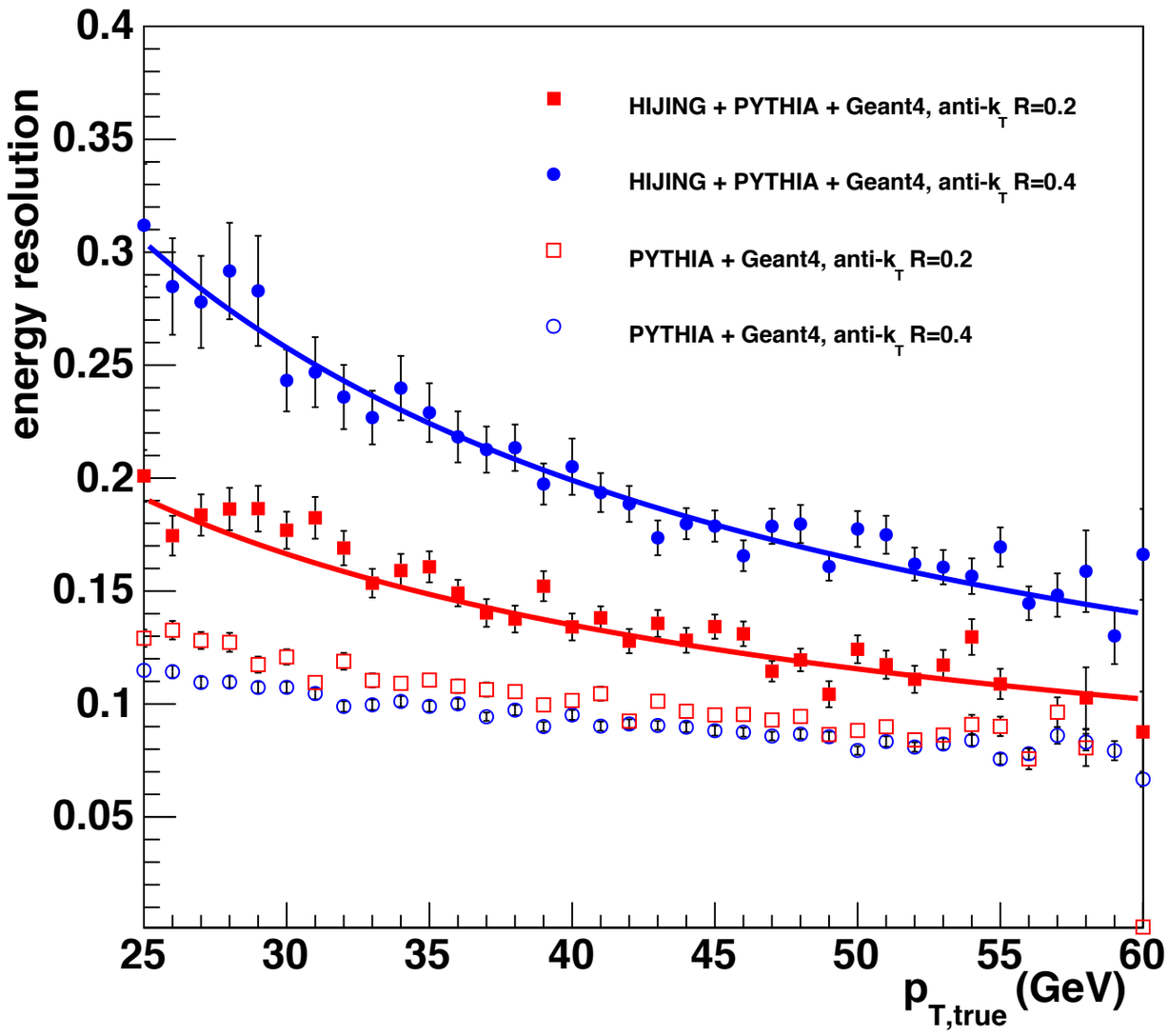
• Main impact hadronic energy and jet energy resolution – low side tail due to fluctuations in energy leakage (easy to quickly GEANT evaluate)

- Jet energy measurement degraded

  ➡ worse resolution, response has long(er?) tails to low/high values

Jet energy measurement





- Characterize jet energy response at a few p_T points
  - ➡ more specifically, **resolution** and **non-Gaussian** tails

Nagle consideration D

One Option - One could multiplex the data to the DCM 2 modules (reducing them by x2) → saves (?)

- Factor of 2 reduction in Au+Au min.bias rate
- No impact on highest energy photon/jet physics, and for pp pA
- Biggest effect is loss of x2 in Upsilons and lower energy jets

- Statistics for rare (triggerable) probes unchanged
  - ➡ no impact for high-p_T jet or photon-jet measurements?
  - ➡ low-p_T measurements probably not statistically limited anyway
- No impact for Jet Structure group?

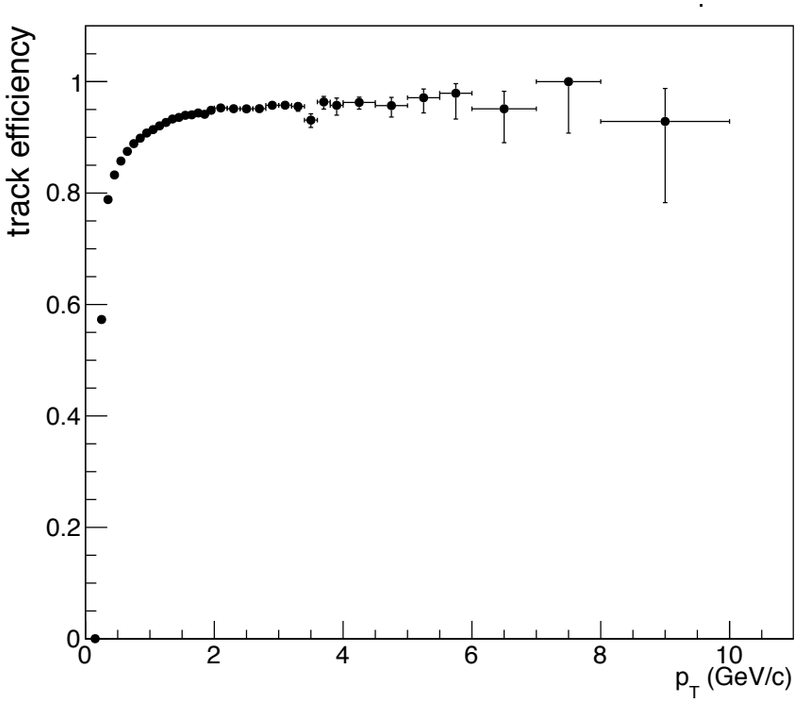
Nagle consideration E

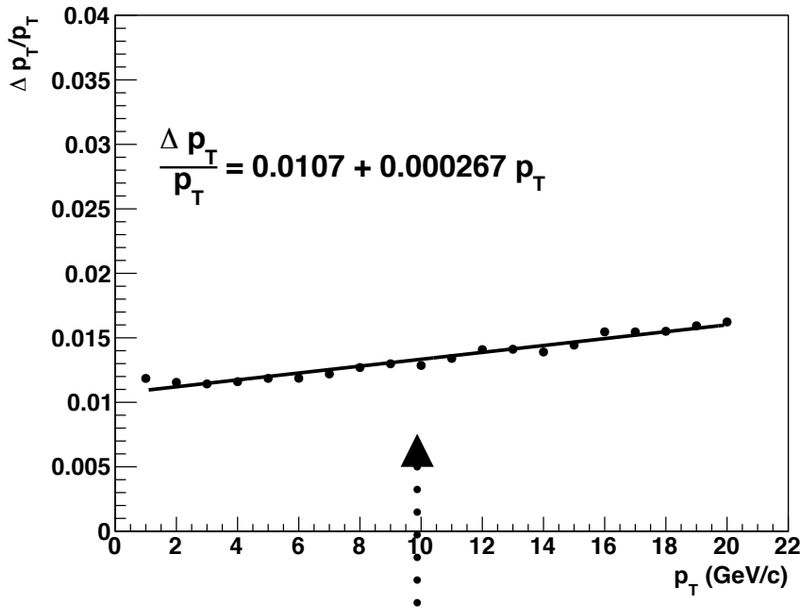
I believe at this point re-using the VTX pixels is a fiction (see the next slide), and that we should put this option aside.
I also have major concerns about the TPC option (really early R&D and no realistic simulation on the horizon for evaluation).

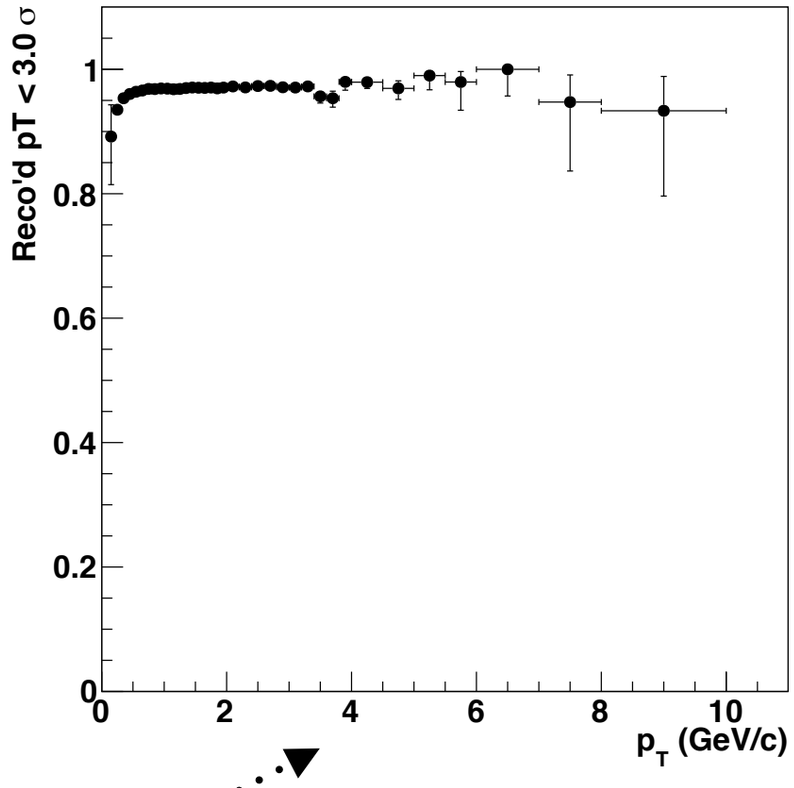
My recommendation to at least pursue is MAPS with one inner pixel layer and reduced N-- outer layers costed to around < $6M.
Evaluate performance for resolution (potentially moving outer layer in) and pattern recognition for Upsilon (with EmCal match) and hadrons (with Calo match).

- Obviously, tracking heavily impacts FF and p_T-flow measurements
  - ➡ efficiency, p_T resolution, fake rate
  - ➡ however, no impact for our group from DCA performance
- Need direction from SP+EC on what configurations will be

Charged particle measurement







MIE single particle simulations

MIE HIJING event simulation

- Characterize **efficiency**, p_T **resolution**, **fake rate**
  - ➡ do it for charged particles inside known jet cone
  - ➡ also valuable to do it in MB Hijing events, but might be more appropriate for Upsilon Topical Group?

Summary of Nagle considerations

A. Ganged EMCal tower readout: minimal impact (for Jet Structure measurements)

B. Half coverage of EMCal: impact on jet response, photon statistics

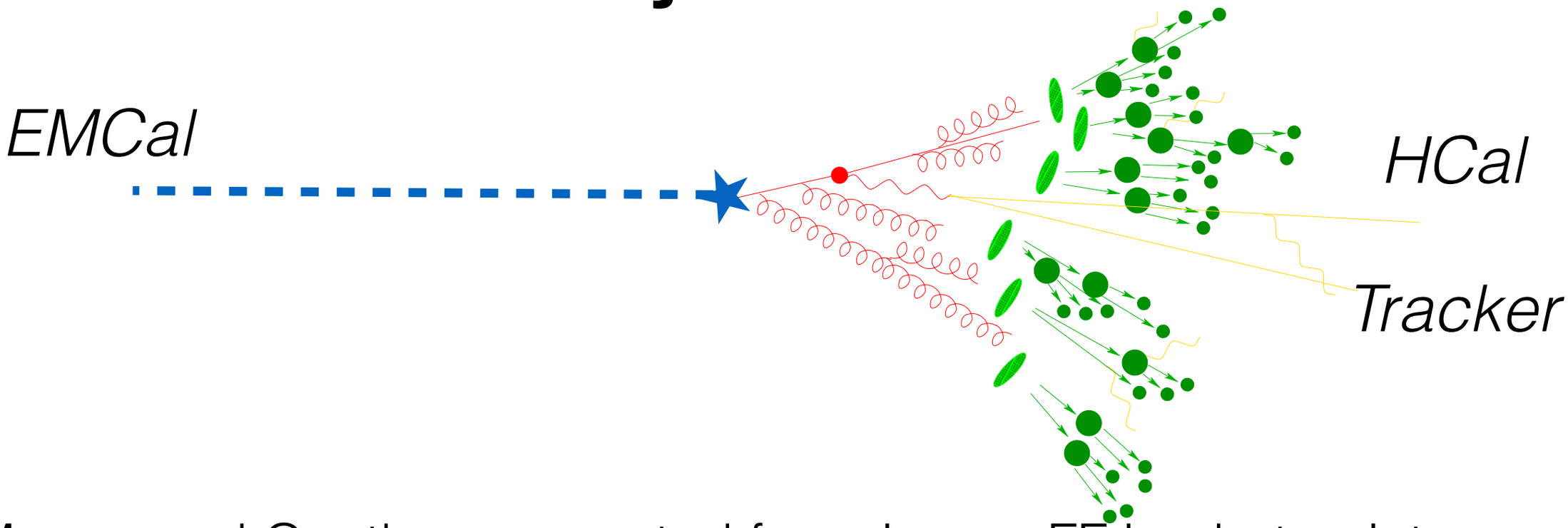
C. Fewer interaction lengths in HCal: potentially major impact on jet response

D. Reduction of MB Au+Au rate: minimal impact for us

E. Various tracking options: major impact on charged particle measurements

- Next set of slides: <u>what simulations should we address these with</u>?

Photon-jet events?



- Megan and Gunther suggested focusing on FF in photon-jet events to simultaneously test multiple systems:
  1. jet energy measurement for HCal + EMCal
  2. efficiency / resolution / fake rate for charged particle tracking inside jet cone
  3. photon ID, resolution for EMCal ← *not affected by descoped options*
- For Berndt's charge, I suggest that ***inclusive jets*** are more appropriate

Strawman simulation proposal

- p_T = 40-45 GeV, $|\eta| < 0.6$ dijet events, full G4 calo sim, N_{evt} = 10k
  - ➡ with truth-level filtering, generate falling jet spectrum in this range
  - ➡ PYTHIA events only — want to know instinct jet response from detector, not from UE
  - ➡ repeat for each calo configuration, so for 3 configurations (nominal, 1/2 EMCal, short HCal) this is 30k events total
- Key observable: jet energy *response* p_T^{reco} / p_T^{true}
- Upon request by Collaboration, could extend study to:
  - ➡ translate given response distribution into syst. uncertainties
  - ➡ explore multiple p_T bins, and/or q/g difference at low p_T
  - ➡ explore effects of UE

Strawman simulation proposal

- Take same set of N_{evt} = 10k, p_T = 40-45 GeV, $|\eta|<0.6$ dijets
  - ➡ do tracking-only simulation, for multiple tracking options
  - ➡ for this study, repeat for PYTHIA only *and* for HIJING-embedded since UE does affect performance
- For 3 (e.g.) tracking configurations, this is 10k events x 3 configs x 2 embeddings = 60k total w/ tracking-only sim
- Key observable: efficiency, fake rate, resolution vs. z
- Could extend study to:
  - ➡ translate given performance into FF systematics?
  - ➡ run 10k+ pure-HIJING events, w/ fast-sim calo matching?
  - ➡ estimate statistical uncertainties vs. z for the FF of p_T = 40, 50, 60 GeV jets?

Summary

- We're getting some idea of the "descoped" detector configurations we'll be asked to evaluate
  - ➡ but still waiting for word from on high
- Propose to evaluate their effect on *jet response* and on high-p_T *charged particle efficiency/resolution/fake rate*
  - ➡ photons are valuable part of physics program, but are not really affected by the particular descoping options
- Propose two simulation samples of 10k: p_T = 40-45 GeV, $|\eta|<0.6$ dijet events: 30k G4 full-calo, 60k G4 tracking-only
  - ➡ do these at a minimum, expand studies if we have time
  - ➡ focus on performance metrics first, then translate to the estimated systematic uncertainties which correspond to these
- Suggestions? Volunteers?